EEE-INST-002: Instructions for EEE Parts Selection, Screening, Qualification, and Derating

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Purpose and Scope

- Provide Project Managers, designers, and parts engineers baseline criteria for parts selection, testing, and derating for part quality levels 1, 2, and 3.
- GSFC Project Managers, contractors, and Principal Investigators shall incorporate EEE-INST-002 into their SOW or MAR, or their equivalents.
- Download EEE-INST-002 from http://nepp.nasa.gov/index_nasa.cfm/725/.
- A total of 400 people from NASA Centers, OEMs, manufacturers, universities, and international agencies have downloaded the document since its inception on the above Web site in June 2003.

Top 60 Organizations

1.	NASA Goddard Space Flight Center	21.	ISRO Satellite Centre	41.	Verhaert Design \& Development NV
2.	BALL CORPORATION	22.	AT&T ITS	42.	Universiteit Utrecht
3.	stanford university	23.	Frequency Electronics INC	43.	Japan Manned Space Systems Corporation
4.	Jet Propulsion Laboratory	24.	BAE Systems Plc	44.	EMS Technologies Canada Ltd.
5.	Lockheed-Martin Corporation	25.	Raytheon Company	45.	TEKDATA
6.	Johns Hopkins Applied Physics Labor	26.	Honeywell, Inc.	46.	Naval Research Laboratory
7.	European Space Operations Center	27.	Swales & Associates, Inc.	47.	ProAxis Communincations, Inc.
8.	Boeing Computer Services	28.	Spectrum Astro Inc.	48.	Cox Communications, Inc
9.	NASA Lewis Network Control Center	29.	GLENAIR FRANCE	49.	Latin American and Caribbean IP address R
10.	The Aerospace Corporation	30.	Northrop Grumman Corp.	50.	Sandia National Laboratories
11.	Japan Network Information Center	31.	General Dynamics Corporation	51.	mission research
12.	ITT Aerospace/Communications Divisi	32.	AEROASTRO	52.	Fraunhofer Institut fuer Informations und Da
13.	University Of Colorado	33.	Satamatics Ltd	53.	Agence Spatiale Canadienne
14.	Qwest Communications International I	34.	Hughes Electronics	54.	AT&T Canada Telecom Services Company
15.	L-3 Communications	35.	Starsys	55.	Deutsche Telekom AG
16.	General Dynamics	36.	Trompeter Electronics, Inc.	56.	Cable Online
17.	NASA Ames Research Center	37.	TELESAT CANADA	57.	OHB Systems AG
18.	SplitRock Services, Inc	38.	ROADRUNNER-WEST	58.	DRS Technologies Inc
19.	QSS GROUP INC	39.	China Mobile Communications Co	59.	Covad Communications Company
20.	Internet Allegiance, Inc.	40.	PSINet, Inc	60.	PROVIDER LOCAL REGISTRY

Part Categories

Part Categories	Document Section	Part Types	Part Specialist
General Requirements for All Part Categories	1	Part quality levels; Part Control Board; military specifications; source control drawings; vendor specifications; commercial parts; PEMs; manufacturer, distributor, and test laboratory assessment; customer source inspection, parts age, storage requirements, parts obsolescence, alerts, radiation effects analysis	Dr. Kusum Sahu
Capacitors	C1	Ceramic, Tantalum, and Mica	Tom Duffy
Connectors	C2	Circular, D sub, microminiature, printed circuit, EMI, MIL-STD-1553, nanominiature, etc.	Terry King
Contacts	C2	Signal, power, PC sockets, coaxial, high voltage	Terry King
Crystals	C3		Gerard F. Kiernan
Crystal Oscillators	C4	Voltage controlled, temperature compensated, oven controlled	Gerard F. Kiernan
Fiber Optics, Passive	F1	Fiber, cable, connector, and assemblies	Dr. Tracee Jamison and Marcellus Proctor
Filters	F2		Tom Duffy
Fuses	F3		Thom Perry
Heaters Magnetics Microcircuits, Hybrid Microcircuits, Monolithic Microcircuits, Plastic Encapsulated (PEMs)	H1 M1 M2 M3 M4	Coils, inductors, transformers	Tom Duffy Gerard F. Kiernan Ashok Sharma Susan Ritter Dr. Alexander Teverovsky
Relays, Electromagnetic	R1	Low level (<25 amps) current, high-level current >25 amps	Thom Perry
Resistors	R2	Composition, film/foil, wire wound	Thom Perry
Semiconductor Devices, Discrete	S1	Diodes, transistors, and MOSFETs	Dennis Krus
Switches	S2	Position sensing, temperature sensing, pressure sensing	Terry King
Thermistors	T1	+ve temperature coefficient, -ve temperature coefficient	Thom Perry
Wire and Cable	W1	Hookup wire, magnet wire, muticonductor cable, coaxial, flexible PC cable	Terry King
Other Part Types	1	Optoelectronic device, ASIC, detector	TBD

Part Quality Level Requirement Vs. Cost

- Goal is to integrate part quality into hardware design for meeting the three reliability levels of EEE parts within budget and schedule constraints.

- ***Level 1:*** Parts shall be selected and processed to this level for missions requiring the **highest reliability and lowest level of risk.** The typical mission duration for level 1 programs is 5 years or greater. Typical microcircuit cost: $1,000 per part.

- ***Level 2:*** Parts shall be selected and processed to this level for missions with **low to moderate risk**, balanced by cost constraints and mission objectives. The typical mission duration for level 2 programs varies from 1 to 5 years. Typical microcircuit cost: $500 per part.

- ***Level 3:*** Parts represent inherently **high risk or unknown risk** because of the lack of formalized reliability assessment, screening, and qualification. Typical microcircuit cost: $50 per part.

  Little dependable data or flight history is available for level 3 parts as the continuous changes in design, materials, and manufacturing processes may make the data on any particular LDC not applicable to another LDC.

  Level 3 parts are intended for mission applications where the use of high-risk parts is acceptable. The typical mission duration for level 3 programs varies from less than 1 year to 2 years.

Part Quality Requirements for Ongoing/Recent GSFC Projects

- Most projects have spacecraft and various instruments built by different OEMs, subcontractors, universities, and international partners.
- EEE-INST-002 provides **detailed instructions** to implement standard selection and testing procedures across the board.

Project	Part Quality Requirement	Project	Part Quality Requirement
JWST	1	SWIFT	3
POES	1	MLA	3
GOES	1	AIMS	3
NPP	2	CINDI	3
EOS/AURA	2	CLOUDSAT	3
GLAST	2	DAWN	3
SDO	2	GALEX	3
GPM	2	GRACE	3
STEREO	2	CHIPS	3
ST-5	2		
HST	2		

Parts Engineering Framework

- Work with GSFC design teams to **select** the BEST QUALITY parts that meet **performance** requirements and meet or exceed **part quality level** requirements.
- Prepare part procurement specifications and coordinate the procurement and storage activities.
- Prepare parts identification lists and supporting part information for approval by Parts Control Board (PCB).
- Coordinate PCB meetings, maintain minutes, and maintain PAPL and ABPL.
- Perform Customer Source Inspections (CSIs) and audits at suppliers' facilities as necessary.
- Disposition/track part nonconformances and part failure investigations.
- Track, report, and resolve impacts of ALERTS and advisories on flight hardware.
- Perform **screening** and **qualification** testing as required by EEE-INST-002.

Part Selection Guidelines

Select in accordance with Table 1 of each section of EEE-INST-002 for each category of parts. Table 1 also indicates when screening and qualification testing are required for each quality level depending upon the part procurement specification.

Part procurement specifications:	**Testing required:**
• Military Drawings	None/Minimum
• SCDs	Significant Testing by Manufacturer
• Manufacturer Screened/Qualified Parts per Purchase Order	Low
• Manufacturer High-Reliability Parts—Catalog Parts	Medium
• Commercial Parts	High
• Plastic Encapsulated Microcircuits (PEMs)	High

Screening, Qualification, and Derating Guidelines

Screening tests are intended to remove infant mortality parts from an otherwise acceptable lot and thus increase confidence in the reliability of the parts selected for use.

Tests shall be performed in accordance with the requirements of **Table 2** of EEE-INST-002 for each category of parts. Typical screening tests include external visual, PIND, seal leak, electrical measurements, temperature cycling, and burn-in.

Qualification tests are intended to verify that materials, design, performance, and long-term reliability of the parts are consistent with the specification, and that manufacturers' processes are consistent from lot to lot.

Tests shall be performed in accordance with the requirements of **Table 3** of EEE-INST-002 for each category of parts. Typical qualification tests include life tests, packaging-related stress tests, electrical measurements, and DPA.

Derating is the reduction of electrical and thermal stresses applied to a part during normal operation in order to decrease the degradation rate and prolong its expected life.

Derating shall be performed in accordance with the requirements set in **Table 4** of EEE-INST-002 for each category of parts.

Discrete Semiconductor Requirements

Table 1

Procurement Specification	Use As Is	Screen to Requirements in Table 2	Qualify to Requirements in Table 3
Level 1:			
1) JANS	X		
2) JANTXV, JANTX **1/**		X	
3) JANJ, SCD		X	X
Level 2:			
1) JANS	X		
2) JANTXV, JANTX **1/**	X **2/**		
3) JANJ, SCD, Mfg. Hi-Rel		X	X
4) Commercial		X	X
Level 3:			
1) JANS	X		
2) JANTXV, JANTX	X **2/**		
3) JANJ	X **2/**		
4) SCD, Mfg. Hi-Rel, Commercial		X	

1/ JANTX parts may be used only if JANTXV parts are not available. For JANTX parts, a five-piece DPA shall be performed.

2/ All cavity devices shall require PIND testing.

Screening Requirements for Monolithic Integrated Circuits

Table 2

	MIL-STD-883		Level 1		Level 2		Level 3	
Inspection/Test	**Methods**	**Conditions**	**SCD**	**883 or Class M**	**883 or Class M**	**SCD/Mfr. Hi-Rel/Commercial**	**883 or Class M**	**SCD/Mfr. Hi-Rel/Commercial**
1. Wafer Lot Acceptance	5007		X	X	X	X		
2. Nondestructive Bond Pull	2023		X	X				
3. Internal Visual	2010	A or B	X	X	X	X		X
4. Temperature Cycling	1010	C	X	X	X	X		
5. Constant Acceleration	2001	E Y_1	X	X	X	X		
6. PIND	2020	A	X	X	X	X	X	X
7. Radiographic	2012	Two views	X	X				
8. Serialization			X					
9. Initial Electrical Measurements			X Read/ Record	X Read/ Record	X Read/ Record	X Read/ Record		X
10. Burn-in	1015	A, C, or D duration (hrs.)	X 72/240	X 48/160	X 160	X 160		X 160
11. Final Electrical Measurements			X Read/ Record	X Read/ Record	X Read/ Record	X Read/ Record		X
12. Calculate Delta			X	X	X	X		

Manufacturer, Distributor, and Test Laboratory Assessment

Assess manufacturers' ability to produce parts with consistent quality as well as the capability to deliver parts on schedule.

Procure from authorized distributors to minimize the risk of receiving parts that have been mismarked or misrepresented, or subjected to substandard storage or handling conditions.

Evaluate test capability and QA processes of **test laboratories** for handling of parts, ESD and humidity control, test plan development and implementation, documentation of test results, etc.

Minimize the usage of any commercial parts for all grade levels. Before initiating the procurement for any commercial part, determine if manufacturers' reliability controls are adequate to ensure production of quality parts.

Related Areas

Radiation Effects. The Radiation Effects Engineer shall be consulted for analysis of the radiation environment and radiation dosage level a proposed part will be exposed to in its application. The project shall document the radiation analysis on each part to show that project-specific radiation requirements are met.

Reliability. The reliability engineer shall be consulted to assess the risk of parts proposed for use in severe applications. Also, the project shall not allow the selection of parts for use outside the manufacturer-specified temperature range without demonstrating that the parts can be used safely beyond their published temperature rating.

Materials. Parts with unstable material properties that cannot be stabilized through additional processing for the proposed application shall not be used. Also, due to the risk of whisker growth that can lead to short-circuit conditions, pure Tin, Cadmium, and Zinc shall not be used as a final finish on EEE parts.

Updated References to Military and NASA Specifications and Test Methods

- A total of approximately 600 military, GSFC, MSFC, and industry specifications and standard test methods are referred to in EEE-INST-002.
- All references to these specifications have been updated, and **links** have been provided for instant access to these documents.

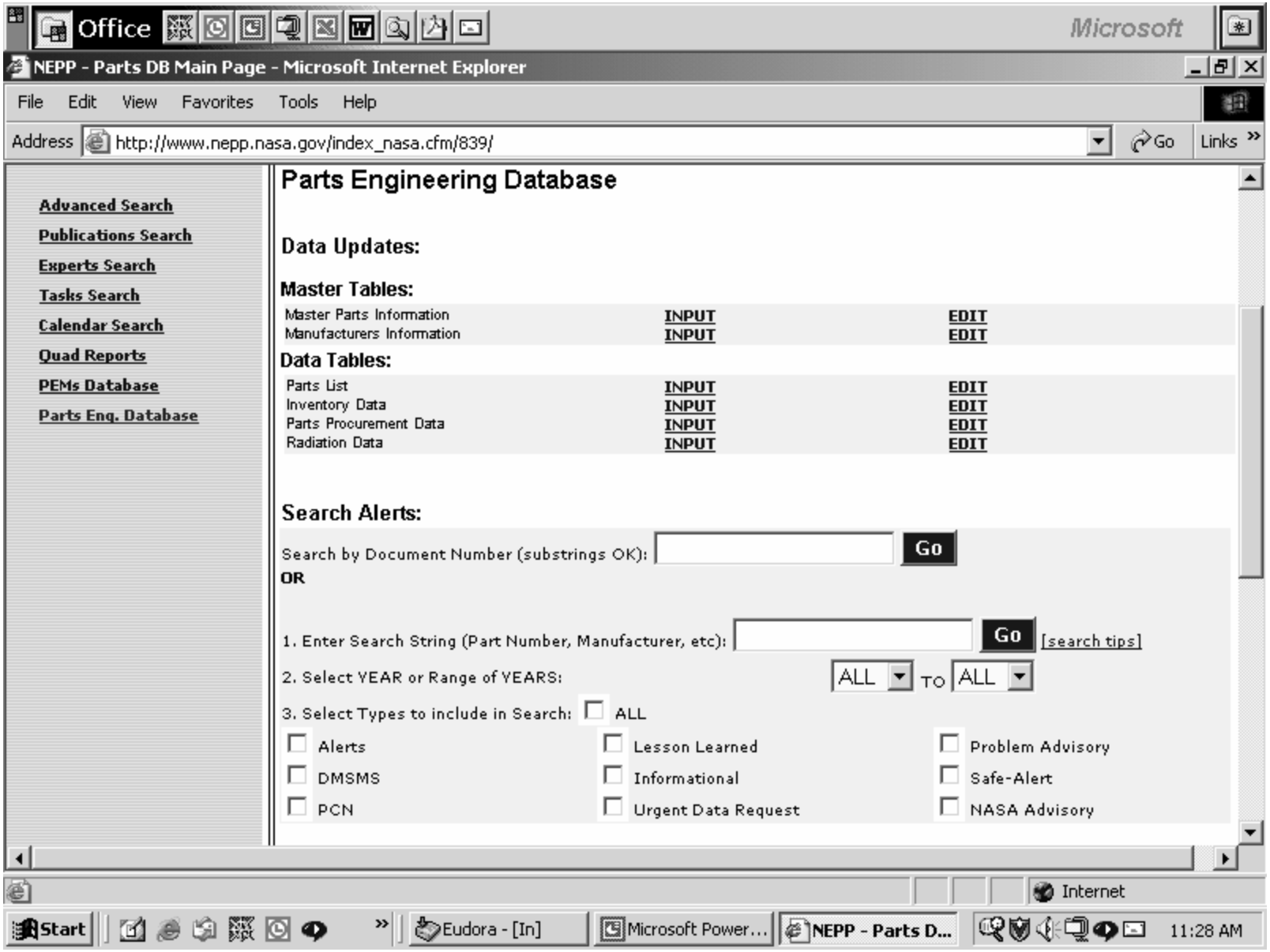
MIL-PRF-20	MIL-PRF-49142/3	S-311-P-18	MIL-STD-202
MIL-PRF-12883	MIL-PRF-39012/61	S-311-M-70	ASTM-13488
MIL-PRF-3098	MIL-C-83517/1	S-311-P-754	ASTM-E595
MIL-PRF-55310	MIL-DTL-83513/1	S-311-P-796	MIL-STD-883
MIL-PRF-28861	MIL-DTL-24308/5	MSFC-STD-355C	MIL-STD-977
MIL-PRF-15305	MIL-C-55302/57	MSFC-40M-39569	NASA-STD-87393
MIL-PRF-38534	DSCC 94023	NEMA-MW-1000	MIL-STD-220
MIL-PRF-38535	DSCC 94046	NEMA-WC-27500	ASTM-E595
MIL-PRF-39016	DSCC 94032	IEC-60758	MIL-STD-750
MIL-PRF-39007	DSCC 94036	A-A-59551	FED-STD-228
MIL-PRF-19500	DSCC 94041	A-A-59569	JEDS-22-A110
MIL-PRF-24236	DSCC 94043	J-W-1177	JEDS-22-A113
MIL-PRF-23648	DSCC 94038	SAE-AS39029	JEDS-22-A118
MIL-PRF-31032	DSCC 94040	S-311-P-4/10	JEDS-22-B106
MIL-PRF-39017	DSCC 94041	S-311-P-4/08	EIA/TIA-455

Current Parts Issues

- Continued/increasing escapes of failing parts in military and space-qualified parts.
- Diminishing sources of manufacturing for many military part types.
- Increasing number of parts with pure Tin finishes, even when the procuring specification does not allow pure Tin.
- Increasing use of high-performance, lightweight, small-sized **commercial** devices requires new approaches for part selection, screening, and qualification.
- Upcoming use of advanced technology packages, i.e., BGA, CGA, requires significant package integrity evaluations.
- Storage, handling, and **installation** of PEMs on board; need guidelines on installation techniques for PEMs.
- Testing delays, particularly qualification and radiation testing for complex microcircuits.
- Procurement of parts from distributors other than the authorized distributor; need for distributor assessment in general.

Integrated Parts Efforts at the Branch Level

- **Parts Control Board:** Formal approval of parts on PAPL via documented PCB meetings with participation from commodity experts; review unique applications and nonconformances; support the development of screening and qualification procedures for commercial devices uniformly across various projects.
- **Failure Review Board:** Track part failure investigations for all parts that fail in test lab or during system-level testing, with the commodity experts and Code 562 personnel.
- **Common Buy:** Significant cost savings for SDO and GPM; also, part quality tends to be higher.
- **GIDEP Alert Impact:** Resolution through a common approach across the projects as much as possible.
- **Online Parts Database:** Standardized parts list formats; GIDEP alert searches on complete parts lists; automatic search on all parts lists for a hit by a new alert.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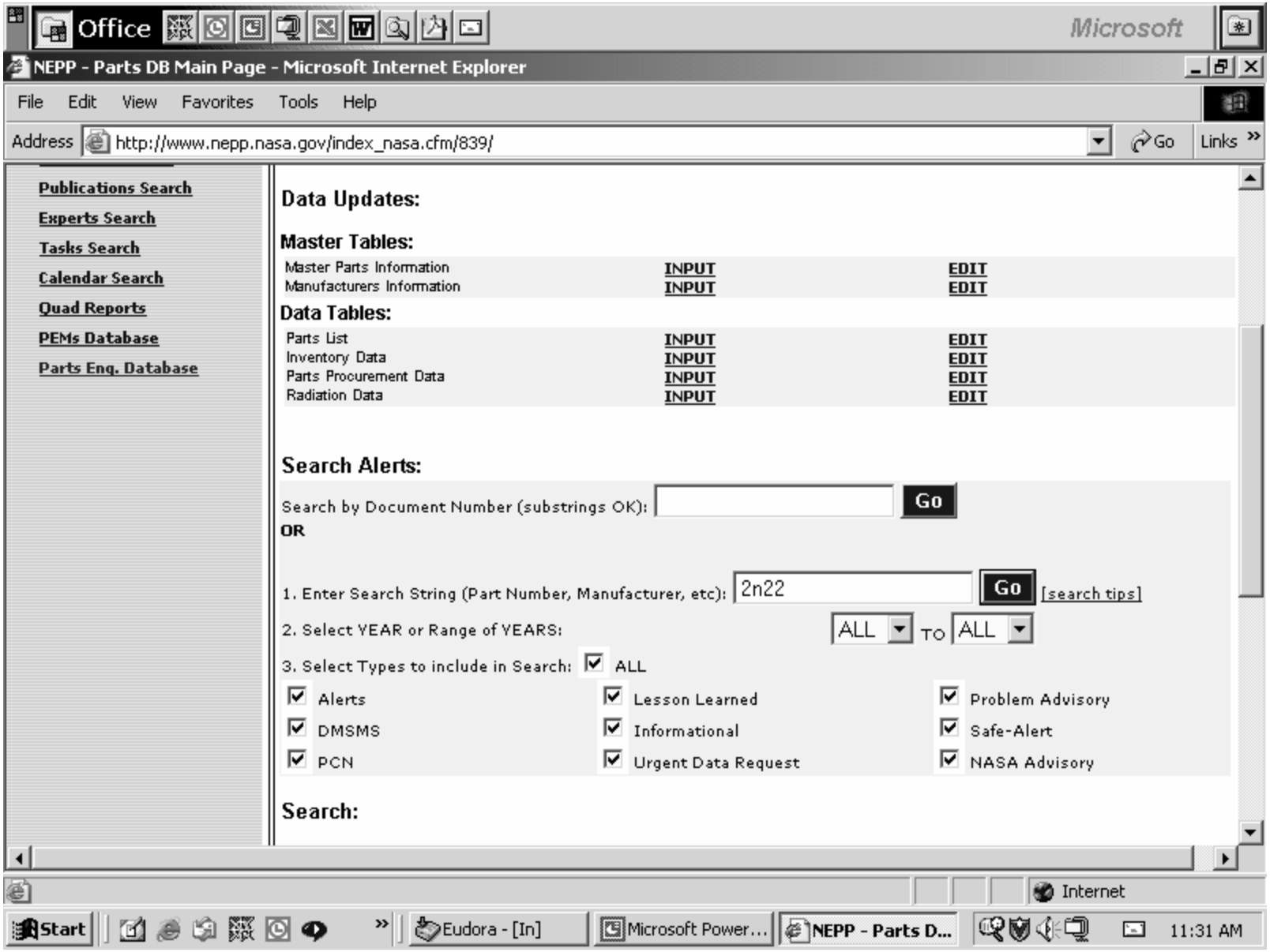
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Parts Procurement Data INPUT EDIT
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2. Select YEAR or Range of YEARS: ALL TO ALL
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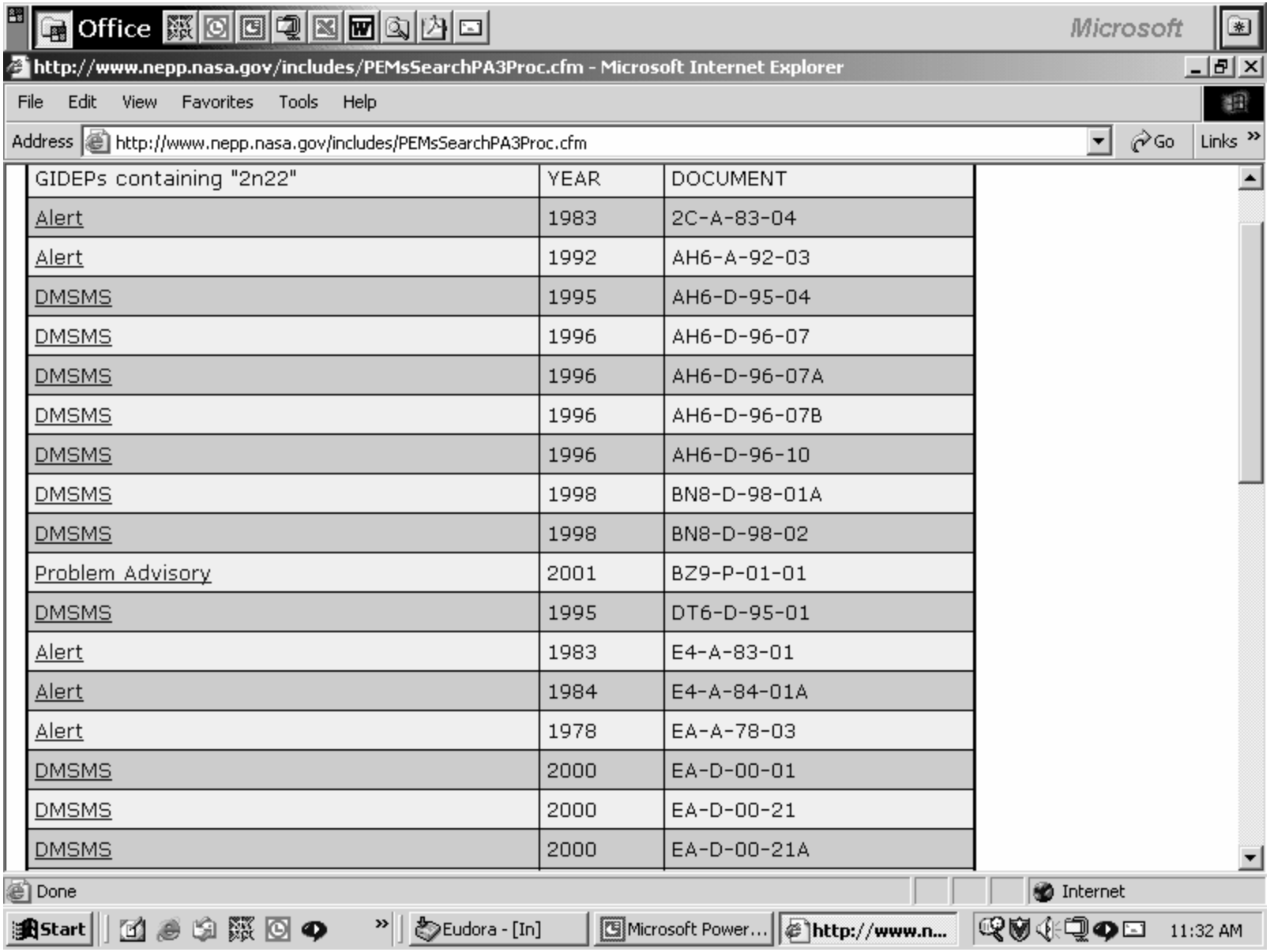
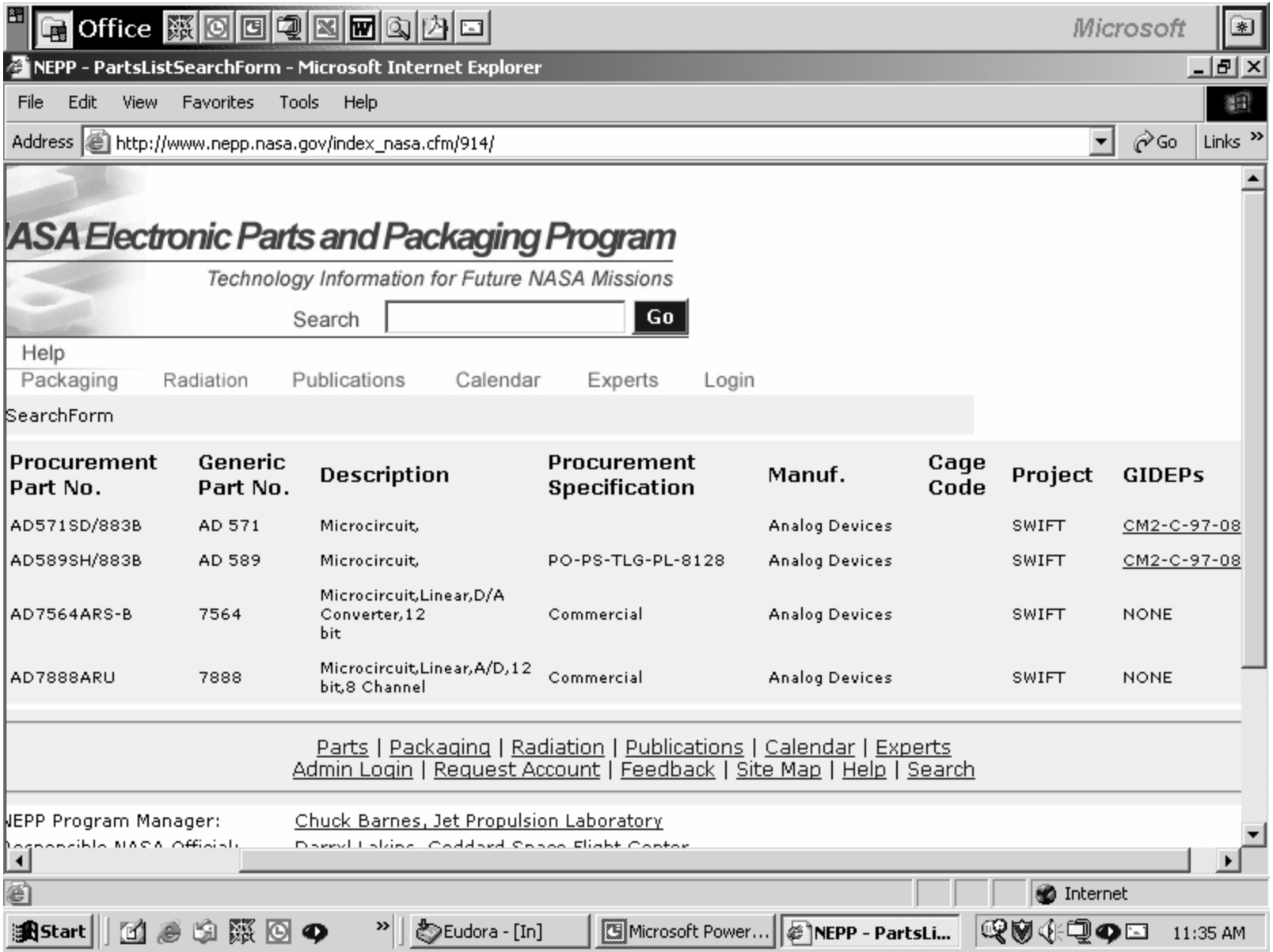


GIDEPs containing "2n22"	YEAR	DOCUMENT
Alert	1983	2C-A-83-04
Alert	1992	AH6-A-92-03
DMSMS	1995	AH6-D-95-04
DMSMS	1996	AH6-D-96-07
DMSMS	1996	AH6-D-96-07A
DMSMS	1996	AH6-D-96-07B
DMSMS	1996	AH6-D-96-10
DMSMS	1998	BN8-D-98-01A
DMSMS	1998	BN8-D-98-02
Problem Advisory	2001	BZ9-P-01-01
DMSMS	1995	DT6-D-95-01
Alert	1983	E4-A-83-01
Alert	1984	E4-A-84-01A
Alert	1978	EA-A-78-03
DMSMS	2000	EA-D-00-01
DMSMS	2000	EA-D-00-21
DMSMS	2000	EA-D-00-21A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ASA Electronic Parts and Packaging Program
Technology Information for Future NASA Missions
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AD 571
Microcircuit,
Analog Devices
SWIFT
CM2-C-97-08
AD589SH/883B
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Analog Devices
SWIFT
CM2-C-97-08
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Analog Devices
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NONE
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GPG on Parts Program Requirements

1. Project Managers are responsible for implementing a Parts Control Program in accordance with EEE-INST-002.
2. Project Managers shall request for a **dedicated Project Parts Engineer** from Code 562 to support and monitor all parts activities at the **start** of the project.
3. A Parts Control Plan shall be prepared by PDR.
4. Identification of the advanced technology parts that require significant interface with manufacturers shall be required by the SRR or PDR.
5. Assessment of manufacturers for building custom parts and/or high reliability versions of COTS parts shall be performed prior to parts procurement.
6. Parts identification lists shall be prepared with the focus on use of **common buy parts.**
7. Screening and qualification plans shall be prepared per EEE-INST-002 for approval by the Parts Control Board.
8. Radiation reviews shall be completed prior to parts procurement.
9. Parts procurement, storage, and handling shall be coordinated through Code 239.
10. Testing of all parts should be coordinated through the Code 562 test lab.
11. A Project Approved Parts List (PAPL) and an As-Built Parts List (ABPL) shall be maintained and submitted to the Code 562 parts database.
12. All testing (screening, qualification, and radiation) shall be completed before kitting of flight parts.
13. Part nonconformances and part failure investigations shall be dispositioned through the Code 562 Failure Review Board and recorded in the parts database.
14. Impact of alerts and advisories on flight hardware shall be coordinated through the GIDEP coordinator.